e-ISSN 2795-4362
p-ISSN 2795-4340

GPH-INTERNATIONAL JOURNAL OF AGRICULTURE & RESEARCH

GPH - JOURNAL OF AGRICULTURE & RESEARCH

10.5281/zenodo.10156495 Vol. 06 Issue 11 Nov - 2023 Manuscript ID: #01105

Effect Type and Dosage of Bokashion the Content of C, N, P, and K in Alluvial Soil

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ABSTRACT

The utilization of dry land is one alternative that can be used to increase national agricultural production, but the productivity of dry land is generally low due to low fertility levels. Efforts to increase the productivity of agricultural land can be made, one of which is by providing organic fertilizer. The research objectives were: (1) to determine the content of C, N, P, and K elements in quail manure bokashi and pineapple skin bokashi; (2) to determine the impact of giving these two bokashi on the content of C-organic, N-total, P-available, and K-available after incubation for 3, 6 and 9 weeks. The research was carried out from January to March 2023 in Samboja District, Kutai Kartanegara Regency, East Kalimantan Province. This research was conducted using a quantitative descriptive method consisting of 7 treatments and 3 repetitions, namely as follows: p0 = control; p1 = bokashi of quail manure 50 g polybag^{-1}; p2 = bokashi of quail manure 100 g polybag^{-1}; p3 = bokashi of quail manure 150 g polybag^{-1}; p4 = bokashi of pineapple skin 50 g polybag^{-1}; p5 = bokashi of pineapple skin 100 g polybag^{-1}; and p6 = bokashi of pineapple skin 150 g polybag^{-1}. The research results show that: (1) The bokashi of quail manurefertilizer content is: 32.29% C-Organic; 3.19%, N-total; C/N ratio 10.12; 41.68 ppm P-available; and 62.63 ppm K-available; The bokashi of pineapple skin fertilizer content is: 33.15% C-organic; 1.61% N-total; C/N ratio 20.59; 33.37 ppm P-available; and 44.38 ppm K-available; (2) applying quail manure bokashi fertilizer to alluvial soil can improve the soil nutrient content C-Organic, N, P, and K better than pineapple skin bokashi fertilizer; and (3) a good incubation period for bokashi fertilizer is 6 weeks.

KEYWORDS:

Type And Dosage of Bokashi, Content of C, N, P, K, Alluvial Soil.

INTRODUCTION

The current decline in national food production is caused by the increasingly narrow area of productive agricultural land (especially on the island of Java) as a result of the conversion of functions such as conversion of paddy fields, plus the global issue of increasing land degradation (in developing countries). Apart from changing functions, rice fields, which have long been considered the backbone of national food production, appear to have begun to decline in productivity due to being saturated by excessive input of artificial/chemical fertilizers. With increasing land conversion and decreasing productivity of paddy fields, the transfer of farming to dry land is becoming increasingly necessary.

Utilization of dry land is one alternative that can be done to increase national agricultural production. The average productivity of dry land currently has a lower productivity level due to low fertility levels, but the potential area is very high. Apart from low productivity, the cropping index is also not optimal because water availability is a limiting factor in farming, so it cannot be carried out all year round. Ministry of Agriculture [1].

The total area of dry land in Indonesia is around 144.47 million ha. Due to its natural nature, around 82% of the total dry land is classified as suboptimal dry land. Acid dry land is suboptimal dry land which occupies the most dominant area, namely around 107.36 million ha (around 74.3% of the total dry land area), while around 10.75 million ha (7.4% of the total dry land area) is Dry land has a dry climate. The areas of acid-dry land and dry climate dry land that have the potential for agricultural development are around 62.64 and 7.76 million ha, respectively. Acid dry land is classified as suboptimal dry land with the main limitation being soil acidity, while the main limitation of dry land with a dry climate is water availability [2].

Acid-dry land with the widest distribution on the islands of Sumatra, Kalimantan, Java, and Papua has the main limiting factors of soil pH which is classified as acid (<5.5), high levels of Al, the element phosphate (P) is not available to plants, the content of alkalis exchangeable and CEC is also low, base saturation <50%, iron and manganese content approaching toxic limits, and poor in biotic elements. Generally, soils in acid-dry land, including the orders Entisols, Inceptisols, Ultisols, and Oxsisols, have low levels of fertility and land productivity, so they require quite high inputs [3]. Areas of acid-dry land are generally found in areas with high rainfall, this is a beneficial factor in terms of water supply. However, with undulatingmountainous areas, the threat of erosion becomes greater, so that apart from soil acidity, erosion is often the main barrier to the development of dry, acidic land for seasonal food crops [4].

Bukit Raya Village, Samboja District, Kutai Kartanegara Regency has soil that contains insufficient N, P, K, and C-Organic nutrients for agriculture, the soil has a clay texture, and the farmers themselves use more chemical fertilizers. According to [5] continuous use of inorganic fertilizers can damage the physical, chemical, and biological properties of the soil so that the level of soil fertility decreases.

Efforts to increase agricultural land productivity can be made by preserving agricultural resources, appropriate strategies, and efforts, one of which is by providing organic fertilizer. According to [6] the use of organic fertilizer has a big influence on the physical, chemical, and biological properties of the soil. Generally, farmers provide it in the form of solid organic fertilizers such as manure and compost. However, with the development of technology to speed up the fermentation process of organic materials using Effective Microorganisms (EM-4), known as bokashi products. Bokashi is the result of fermentation of organic material with EM-4 which can be used as

organic fertilizer to increase soil fertility and increase plant growth and yield [7]. The advantages and benefits of bokashi organic fertilizer are that it increases the diversity, population, and activity of beneficial soil microorganisms, suppresses the development of bacteria (disease germs), contains macronutrients (Phosphorus, Nitrogen, Potassium, Magnesium, Calcium, and Sulfur) and micronutrients (Cuprum, Feron, Boron, Zincum and others), increases soil pH, increases humus content in the soil, increases soil looseness, efficiency of use of inorganic fertilizers, increases fertility and plant production [8].

In Samboja District, there is a lot of organic waste, namely quail droppings and pineapple peel plantation waste. Quail breeders in Samboja District are managed individually with an average number of 3000-5000 quail, but most of the quail waste itself is only thrown away when cleaning the cage and is not used. Even though quail waste contains 2.86% N-total; 0.209% P2O5, 3.133% K2O, and 21.00% protein [9].

Pineapple plantations in Samboja District, Kutai Kartanegara Regency are the largest pineapple-producing areas in East Kalimantan Province with the largest planting area for each farmer group being 55 ha with an average pineapple production yield per harvest of 35 tons/ha. In the use of pineapple fruit, a lot of waste is produced in the form of the skin. Pineapple skin contains quite high levels of carbohydrates and sugar, namely containing 81.72% water; 20.87% crude fiber; 17.53 % carbohydrates; 4.41% protein, and 13.65% reducing sugar [10]. The contents of these two ingredients can be used as ingredients in making bokashi fertilizer.

The research objectives were: (1) to determine the content of the elements N, P, K, and C in quail droppings bokashi and pineapple skin bokashi; (2) to determine the impact of giving these two bokashi on the N, P, K, and C content in the alluvial soil after incubation for 3, 6 and 9 weeks.

RESEARCH METHODOLOGY

1. Time and Place

The research was carried out from January to March 2023 in Samboja District, Kutai Kartanegara Regency, East Kalimantan Province, Indonesia

2. Materials and Tools

The materials used are planting media in the form of alluvial topsoil taken from Bukit Raya Village, Samboja District, quail manure, pineapple skin waste, bran, rice husks, EM-4, water, bray and Kurt extractor, catalyst dye, and acid. sulfate, and distilled water. The tools used are hoes, buckets, polybags, sacks, tarpaulins, knives, machetes, meters, documentation tools, writing tools, calculating tools, scales, sieves, < 2 mm sieve filters, ovens, analytical balances, dispensers, test tubes, pipettes 1 ml, filter paper, glass funnel, shake bottle, shaker machine, spectrophotometer, stir bottle, funnel, and stirrer spoon.

3. Treatment Design

This research was conducted using a quantitative descriptive method consisting of 7 treatments and 3 repetitions, namely as follows: p0 = control; p1 = bokashi of quail manure 50 g polybag^{-1}; p2 = bokashi of quail manure 100 g polybag^{-1}; p3 = bokashi of quail manure 150 g polybag^{-1}; p4 = bokashi of pineapple skin 50 g polybag^{-1}; p5 = bokashi of pineapple skin 100 g polybag^{-1}; and p6 = bokashi of pineapple skin 150 g polybag^{-1}.

4. Research Procedures

Research activities include: (a) making bokashi, (b) preparing planting media in polybags; (c) providing treatment with the type and dose of bokashi, (d) incubation for 3, 6, and 9 weeks, (e) taking soil samples from each polybag; (f) soil analysis after treatment in the laboratory, namely organic-C, total N content, C/N ratio, P-available, and K-available. Laboratory test results were assessed based on criteria from the Bogor Soil Research Center (PPT) 2009.

RESULTS AND DISCUSSION

A. Initial Analysis Results

This initial analysis was carried out to determine the content of C-organic, N-total, P-available, and K-available before treatment was given. The results of the initial analysis are presented in Table 1.

Table 1. Results of Initial Stage Analysis of Soil, Quail Dung Bokashi, and Pineapple Peel Bokashi

Sample	C-Oganik (%)	N-Total (%)	C/N	P-Availabe (ppm)	K-Availabe (ppm)
Planting Media (Alluvial Soil)	2,44 (S)	0,26 (S)	9,47 (S)	29,55 (T)	212,50 (S)
Bokashi of Quail Manure	32,29	3,19	10,12	41,68	62,63
Bokashi of Pineapple Skin	33,15	1,61	20,59	33,37	44,38

The results of the analysis have soil chemical characteristics with C-Organic content = 2.44% (medium), N-total = 0.26% (medium), C/N ratio = 9.47 (low), P-available = 29 .55 ppm (high), and K-available= 212.50 (medium). The content of quail manure bokashi fertilizer is: C-Organic = 32.29%, N-total = 3.19%, C/N ratio = 10.12, P-available = 41.68 ppm, and K-available = 62 .63 ppm. The bokashi of pineapple skin content is C-organic = 33.15; N-total = 1.61%; C/N ratio = 20.59; P-available = 33.37 ppm, and K-available = 44.38 ppm.

2. Soil C-Organic Content After Bokashi Application

The results of the analysis of soil organic C content after treatment with bokashi of quail manure fertilizer and bokashi of pineapple skin fertilizer which were incubated for 3, 6, and 9 weeks are presented in Table 2.

Table 2. Results of Soil C-Organic Content Analysis

Treatment	3 MSI	Status	6 MSI	Status	9 MSI	Status
p0	1,79	R	1,17	R	1,22	R
p1	1,81	R	1,21	R	1,18	R
p2	2,32	S	2,11	S	1,62	R
p3	2,65	S	1,51	R	1,64	R
p4	2,19	S	1,68	R	1,48	R
p5	2,11	S	1,50	R	1,73	R
p6	2,18	S	1,45	R	2,89	S

Source: *Analysis Results (Soil Science Laboratory, Faculty of Agriculture, Mulawarman University 2023) Information: MSI (Week After Incubation), SR (Very Low), R(Low), S(Medium), T(High), and ST(Very High).*

Table 2 shows that the application of 2 types of bokashi fertilizer which were incubated for 3 - 9 weeks was able to increase the organic C content of the soil. There was a varied increase in C-Organic after incubation. The organic C content in the bokashi treatment of quail manure after 3 weeks of incubation (1.81 - 2.65%), after 6 weeks of incubation (1.21 - 1.51%), and after 9 weeks of incubation (1.18 - 1.64%). The C-organic content in the bokashi treatment of pineapple skin after 3 weeks incubation (2.11 - 2.19%), after 6 weeks incubation (1.45 - 1.68%), and after 9 weeks incubation (1.48 - 2.89%), while in the treatment without bokashi (control) it was 1.79; 1.17 and 1.22% (low), can increase carbon levels in the soil as well as organic acids that come from the weathering of organic material.

Even though there was an increase in the soil organic C content by treatment with various doses of bokashi, the soil organic C content after incubation for 3 - 9 weeks showed a tendency to decrease the soil organic C content compared to the initial soil organic C content, namely 2.44% (medium). This is because bokashi is the result of fermentation of organic material using EM-4, adding bokashi to the soil can encourage the decomposition process of organic material which causes the decomposition of C. It was stated by [12] Afandi et al (2015) that C is a food source for soil microorganisms. , so that the presence of organic C in the soil will stimulate the activity of microorganisms thereby increasing the soil decomposition process and also reactions that require the help of microorganisms.

3. Soil N-Total Content After Bokashi Application

The results of the analysis of the total N content of the soil after treatment with bokashi of quail manure fertilizer and bokashi of pineapple skin fertilizer which were incubated for 3, 6, and 9 weeks are presented in Table 3.

Table 3. Results of the Analysis of Soil N-total Content

Treatment	3 MSI	Status	6 MSI	Status	9 MSI	Status
p0	0,14	R	0,33	S	0,20	R
p1	0,15	R	0,34	S	0,26	S
p2	0,17	R	0,29	S	0,12	R
p3	0,20	R	0,41	S	0,23	S
p4	0,16	R	0,24	S	0,23	S
p5	0,21	S	0,20	R	0,14	R
p6	0,20	R	0,25	S	0,27	S

Source: Analysis Results (Soil Science Laboratory, Faculty of Agriculture, Mulawarman University 2023) Information: MSI (Week After Incubation), SR (Very Low), R (Low), S (Medium), T (High), and ST (Very High).

Table 3 shows that the application of 2 types of bokashi fertilizer which were incubated for 3, 6, and 9 weeks was able to increase the total N content of the soil, namely as follows: total N content in the bokashi of quail manure treatment after 3 weeks of incubation (0.15- 0.20%), after 6 weeks incubation (0.29 - 0.41%), and after 9 weeks incubation (0.12 - 0.26%). Total N content in the bokashi

of pineapple skin treatment after 3 weeks incubation (0.16 - 0.21%), after 6 weeks incubation (0.20 - 0.25%), and after 9 weeks incubation (0.14 - 0.27%), while in the treatment without bokashi (control), the soil N-total content was respectively 0.14; 0.33 and 0.29% (classified as low). This shows that the application of organic matter can increase the total N content of the soil. As stated by [13] and [14] the presence of bokashi also influences the increase in total N levels of Regosol. This can happen because bokashi contains high levels of N, so the more doses added, the greater the N content in the soil. The addition of organic matter can increase the total N content in the soil, both in the form of organic N and mineral N.

In general, the research results showed that the total N content of the soil decreased after 3 weeks of incubation, then increased again after 6 weeks of incubation, and decreased again after 9 weeks of incubation. This is because the addition of organic material causes an increase in total soil N, although the increase is not striking. Organic material will undergo a gradual decomposition process, with the presence of several nutrients in the organic material it will release complex carbon bonds into simple bonds. This increase in soil N-total comes from the mineralization of the bokashi organic material provided. It was explained by [15] that the process of loss of N in the soil can be caused by the use of microorganisms, N is still in the form of NH4+ which is bound by clay minerals, N is also still in the form of NO3- which is easily leached by rainwater, and can denitrification and volatilization processes occur.

4. P-Available Content Soil after Giving Bokashi

The results of the analysis of available P content in the soil after treatment with quail manure bokashi fertilizer and pineapple skin bokashi fertilizer which were incubated for 3, 6, and 9 weeks are presented in Table 4.

Table 4. Results of Analysis of Soil P-Available Content

Treatments	3 MSI	Status	6 MSI	Status	9MSI	Status
p0	52,61	ST	47,43	ST	29,72	ST
p1	40,95	ST	34,47	ST	30,15	ST
p^2	39,22	ST	47,86	ST	33,61	ST
p3	67,30	ST	85,87	ST	41,81	ST
p4	40,95	ST	82,63	ST	51,75	ST
p5	34,47	ST	31,02	ST	21,51	ST
p6	27,99	ST	26,70	ST	23,24	ST

Source: Analysis Results (Soil Science Laboratory, Faculty of Agriculture, Mulawarman University 2023) Information: MSI (Week After Incubation), SR (Very Low), R (Low), S (Medium), T (High), and ST (Very High).

Table 4 shows that the application of 2 types of bokashi fertilizer which were incubated for 3, 6, and 9 weeks resulted in varying soil available P content, namely as follows: available P content in the bokashi of quail manure after treatment 3 weeks incubation (39,22 - 67.30 ppm), after 6 weeks of incubation (34.47 - 85.87 ppm), and after 9 weeks of incubation (30.15 - 41.81 ppm). P-available content in the bokashi of pineapple skin treatment after 3 weeks of incubation (27.99- 40.95 ppm), after 6 weeks of incubation (26.70 - 82.63 ppm), and after 9 weeks of incubation (21.51 - 51.75 ppm), while in the treatment without bokashi (control) the soil available P content was respectively 52.61; 47.43 and 29.72 ppm (classified as very high). Providing organic fertilizer increases the availability of

P because the organic component will release CO_2 and higher CO_2 concentrations, and will increase the decomposition process of organic matter and phosphate minerals so that the availability of P in the soil will also increase [16].

Table 4 also shows that all bokashi treatments increased P-available after 3 and 6 weeks of incubation, but decreased again after incubation for 9 weeks. This is because the application of bokashi encourages the release of P fixed by Al and Fe in acidic soil, thereby increasing the P-available in the soil solution. The effect of organic matter on P availability can be directly through the mineralization process or indirectly through the release of fixed P. The results of the decomposition of organic materials in the form of organic acids form chelation bonds with Al and Fe ions, thereby reducing the solubility of Al and Fe ions. The results of this study are in line with the report of [17] which shows that all bokashi dose treatments increased P availability at 30 days after incubation, and decreased after incubation 60 days after planting.

5 K-Available Content Soil after Giving Bokashi

The results of the analysis of K-available content in the soil after treatment with bokashi of quail manure fertilizer and bokashi of pineapple skin fertilizer which were incubated for 3, 6, and 9 weeks are presented in Table 5.

Table 5. Results of Analysis of Soil K-Available Content

Treatments	3 MSI	Status	6 MSI	Status	9MSI	Status
p0	268,18	T	302,73	T	310,00	T
p1	424,55	ST	391,82	ST	466,36	ST
p2	559,09	ST	473,64	ST	535,45	ST
p3	720,91	ST	793,64	ST	730,00	ST
p4	513,64	ST	333,64	T	415,45	ST
p5	551,82	ST	422,73	ST	526,36	ST
p6	617,27	ST	540,91	ST	590,00	ST

Source: Analysis Results (Soil Science Laboratory, Faculty of Agriculture, Mulawarman University 2023) Information: MSI (Week After Incubation), SR (Very Low), R (Low), S (Medium), T (High), and ST (Very High).

Table 5 shows that the application of 2 types of bokashi fertilizer which were incubated for 3, 6 and 9 weeks resulted in varying of soil K-available content, namely as follows: K-available content in the bokashi of quail manure treatment after 3 weeks of incubation (424.25 - 720.91 ppm), after 6 weeks of incubation (391.82 - 793.64 ppm), and after 9 weeks of incubation (466.36 - 730.00 ppm). K-available content in bokashi of pineapple skin treatment after 3 weeks incubation (513.64- 617.27 ppm), after 6 weeks incubation (333.64 - 540.91 ppm), and after 9 weeks incubation (415.45 - 590.00 ppm), while in the treatment without bokashi (control) the soil-available K content was respectively 268.18; 302.73 and 310.002 ppm (classified as high). The available K content in the soil before treatment was 212.50 ppm. Based on this data, giving bokashi can increase the K-available in the soil. In connection with availability K. [18] explains that the application of organic material can increase the K-dd of the soil by 1.02 $cmolkg^{-1}$ (through decomposition of organic material) so that potassium will be available in the soil because potassium is not easily leached.Furthermore, the research results reported by[19] thatSoil without bokashi and guano fertilizer or control shows medium status, in contrast to land that has been added with straw bokashi and guano fertilizer which shows a very high

K-available status, this shows that the application of straw bokashi and guano fertilizer can increase potassium in the soil; and and other reported research results [20]that giving bokashi at a dose of 10 - 30 tons ha^{-1} which was incubated for 1 and 2 months produced a higher exchangeable K content compared to treatment without giving bokashi.

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

1. The content of quail droppings bokashi fertilizer is 32.29% C-Organic; 3.19%, N-total; C/N ratio10.12; 41.68 ppm P-available; and 62.63 ppm K-available; The bokashi content of pineapple skin is: 33.15% C-organic; 1.61% N-total; C/N ratio 20.59; 33.37 ppm P-available; and 44.38 ppm K- available.
2. Applying bokashi of quail manure fertilizer to alluvial soil can improve the soil nutrient content C-Organic, N, P, and K better than bokashi of pineapple skin fertilizer.
3. The incubation period for bokashi fertilizer is 6 weeks

B. Suggestions

1. Using bokashi of quail manure to improve the N, P, and K content should use a dose of 50 - 100 gin polybags.
2. Using bokashi of pineapple skin to improve the N and C-Organic content should use a dose of 100 -150 g $polybag^{-1}$.

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